Express Mail Label No. EV 442788338 US

# [0001] MATERIAL ADAPTED TO DISSIPATE AND REDUCE VIBRATIONS AND METHOD OF MAKING SAME

## [0002] CROSS REFERENCE TO RELATED APPLICATION

[0003] This application is a continuation in part of and claims priority from the following four U.S. patent applications: (1) U.S. patent application 10/360,353, filed February 7, 2003, entitled "Material Adapted to Dissipate and Reduce Vibrations and Method of Making Same" which is hereby incorporated by reference herein as if fully set forth in its entirety; (2) U.S. patent application 10/173,063, filed June 17, 2002, entitled "Material Adapted to Dissipate and Reduce Vibrations and Method of Making Same" which is hereby incorporated by reference herein as if fully set forth in its entirety; (3) U.S. Patent Application 10/165,748, entitled "Multi-Layer Material Adapted to Dissipate and Reduce Vibrations," filed on June 7, 2002, which is hereby incorporated by reference herein as if fully set forth in its entirety; and (4) U.S. Patent Application 10/346,954, entitled "Material Adapted to Dissipate and Reduce Vibrations and Method of Making Same," filed on January 17, 2003, which is hereby incorporated by reference herein as if fully set forth in its entirety.

[0004] BACKGROUND

[0005] The present invention is directed to a material adapted to reduce vibration and, more specifically, to a method of making a material adapted to dissipate and evenly distribute vibrations acting on the material.

[0006] Handles of sporting equipment, bicycles, hand tools, etc. are often made of wood, metal or polymer that transmit vibrations that can make the items uncomfortable for prolonged gripping. Sporting equipment, such as bats, balls, shoe insoles and sidewalls, also transmit vibrations during the impact that commonly occurs during athletic contests. These vibrations can be problematic in that they can potentially distract the player's attention, adversely effect performance, and/or injure a portion of a player's body.

[0007] Rigid polymer materials are typically used to provide grips for tools and sports equipment. The use of rigid polymers allows users to maintain control of the equipment but is not very effective at reducing vibrations. While it is known that softer materials provide better vibration regulation characteristics, such materials do not have the necessary rigidity for incorporation into sporting equipment, hand tools, shoes or the like. This lack of rigidity allows unintended movement of the equipment encased by the soft material relative to a user's hand or body.

[0008] Additionally, injuries to the body can result in strained or sprained ligaments and bruised muscles or the like. Once an athlete has been injured it is

necessary to support the injured portion of the athlete's body while minimizing the vibration experienced by the injured portion during further activity.

[0009] Prolonged or repetitive contact with excessive vibrations can injure a person. The desire to avoid such injury can result in reduced athletic performance and decreased efficiency.

[0010] Clearly what is needed is a method of making a material adapted to regulate vibration that provides the necessary rigidity for effective vibration distribution and for a user to maintain the necessary level of activity; and that can dampen and reduce vibrational energy.

## [0011] SUMMARY

[0012] One embodiment of the present invention is directed to an athletic tape for wrapping a portion of a person's body. The athletic tape has a longitudinal axis and is adapted to provide a controlled support for the portion of the person's body. The athletic tape includes a tape body that is stretchable along the longitudinal axis from a first position to a second position, in which the tape body is elongated by a predetermined amount relative to the first position. The tape body includes a first elastomer layer defining a tape length, as measured along the longitudinal axis of the tape body. The support structure is disposed within the elastomer layer generally along the longitudinal axis in an at least partially non linear fashion while the tape body is in the first position so that a length of the support structure, as measured along

a surface thereof, is greater than the tape length of the first elastomer layer. When the tape body is stretched into the second position, the support structure is at least partially strengthened out so that the support structure is more linear, relative to when the tape body is in the first position. The straightening of the support structure causes energy to be dissipated and generally prevents further elongation of the elastomer layer along the longitudinal axis past the second position. The support structure includes a plurality of fibers.

[0013] In another aspect, the present invention is directed to an athletic tape for wrapping a portion of a person's body. The athletic tape has a longitudinal axis and is adapted to provide a controlled support for the portion of the person's body. The athletic tape includes a tape body that is stretchable along the longitudinal axis from a first position to a second position, in which the tape body is elongated by a predetermined amount relative to the first position. The tape body includes a first elastomer layer that defines a tape length, as measured along the longitudinal axis, of the tape body. A support structure is disposed at least partially within the elastomer layer generally along the longitudinal axis in an at least partially non linear fashion while the tape body is in the first position so that a length of the support structure, as measured along a surface thereof, is greater than the tape length of the first elastomer layer. When the tape body is stretched into the second position, the support structure is at least partially straightened so that the support structure is more linear, relative to when the tape body is in the first position. The straightening of the support

structure causes energy to be dissipated and generally prevents further elongation of the elastomer layer along the longitudinal axis past the second position.

[0014] In another aspect, the present invention is directed to a material having a stretch axis and that is adapted to regulate energy by distributing and partially dissipating energy exerted thereon. The material includes a material body that is elongateable along a stretch axis from a first position to a second position, in which the material is elongated by a predetermined amount relative to the first position. The material body includes a first elastomer layer defining a material length, as measured along the stretch axis, of the material body. A support structure is disposed within the elastomer layer generally along the stretch axis in an at least partially non linear fashion while the material body is in the first position so that a length of the support structure, as measured along a surface thereof, is greater than the material length of the first elastomer layer. When the material body is elongated into the second position, the support structure is at least partially straightened so that the support structure is more linear, relative to when the material body is in the first position. The straightening of the support structure causes energy to be dissipated and generally prevents further elongation of the elastomer layer along the stretch axis past the second position.

[0015] In another aspect, the present invention is directed to a padding for covering a portion of a person's body to provide support and/or impact for the portion. The padding has a stretch axis. The padding includes a padding body that is

elongateable along the stretch axis from a first position to a second position, in which the padding body is elongated by a predetermined amount relative to the first position. The padding body includes a first elastomer layer that defines a padding length, as measured along the stretch axis, of the padding body. A support structure is disposed within the elastomer layer generally along the stretch axis in an at least partially non linear fashion while the padding body is in the first position so that a length of the support structure, as measured along a surface thereof, is greater than the padding length of the first elastomer layer. When the padding body is elongated into the second position, the support structure is at least partially straightened so that the support structure is more linear, relative to when the padding body is in the first position. The straightening of the support structure causes energy to be dissipated and generally prevents further elongation of the elastomer layer along the stretch axis past the second position.

[0016] In another aspect, the present invention is directed to a brace for wrapping a portion of a person's body. The brace has a stretch axis and is adapted to provide a controlled support for the portion of the person's body. The brace includes a brace body that is elongateable along the stretch axis from a first position to a second position in which the brace body is elongated by a predetermined amount relative to the first position. The brace body includes a first elastomer layer that defines a brace length, as measured along the stretch axis, of the brace body. A support structure is disposed within the elastomer layer generally along the stretch axis in an at least

partially non linear fashion while the brace body is in the first position so that a length of the support structure, as measured along a surface thereof, is greater than the brace length of the first elastomer layer. When the brace body is stretched into the second position, the support structure is at least partially straightened so that the support structure is more linear, relative to when the brace body is in the first position. The straightening of the support structure causes energy to be dissipated and generally prevents further elongation of the elastomer layer along the stretch axis past the second position.

[0017] In another aspect, the present invention is directed to an athletic tape for wrapping a portion of a person's body. The athletic tape has a longitudinal axis and is adapted to provide a controlled support for the portion of the person's body. The athletic tape includes a tape body that is stretchable along the longitudinal axis from a first position to a second position, in which the tape body is elongated by a predetermined amount relative to the first position. The tape body includes a first elastomer layer that defines a tape length, as measured along the longitudinal axis of the tape body. A support structure is disposed over the elastomer layer and contacts the elastomer layer at a plurality of locations. The support structure extends generally along the longitudinal axis in an at least partially non linear fashion while the tape body is in the first position so that a length of the support structure, as measured along a surface thereof, is greater than the tape length of the first elastomer layer. When the tape body is stretched in the second position, the support structure is at least partially

strengthened so that the support structure is more linear, relative to when the tape body is in the first position. The support structure includes a plurality of fibers.

[0018] BRIEF DESCRIPTION OF THE DRAWINGS

[0019] The foregoing summary, as well as the following detailed description of the preferred embodiments of the present invention will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there are shown in the drawings embodiments which are presently preferred. It is understood, however, that the invention is not limited to the precise arrangements and instrumentality shown. In the drawings:

[0020] Figure 1 is a cross-sectional view of a preferred embodiment of the material of the present invention illustrating a single layer vibration dissipating material with a support structure embedded therein, the material extends along a longitudinal portion of an implement and covers a proximal end thereof;

[0021] Figure 2 is a cross-sectional view of the material of Figure 1 separate from any implement, padding, equipment or the like;

[0022] Figure 2A is a cross-sectional view of a second preferred embodiment of the material of the present invention with the support structure embedded thereon and the vibration dissipating material penetrating the support structure;

[0023] Figure 2B is cross-sectional view of a third preferred embodiment of the material of the present invention with the support structure embedded within the

vibration dissipating material and the vibration dissipating material penetrating the support structure, the support structure is positioned off center within the vibration dissipating material;

[0024] Figure 3 is a cross-sectional view of a first preferred embodiment of the support structure as taken along the lines 3-3 of Figure 2, the support structure is formed of polymer and/or elastomer and/or fibers, either of which may contain fibers, passageways extend through the support structure allowing the vibration dissipating material to penetrate the support structure;

[0025] Figure 4 is cross-sectional view of a second preferred embodiment of the support structure as viewed in a manner similar to that of Figure 3 illustrating a support structure formed by woven fibers, passageways through the woven fibers allow the support structure to be penetrated by the vibration dissipating material;

[0026] Figure 5 is cross-sectional view of a third preferred support structure as viewed in a manner similar to that of Figure 3; the support structure is formed by pluralities of fibers and particles; passageways past the fibers allow the vibration dissipating material to preferably penetrate the support structure;

[0027] Figure 6 is a side elevational view of the support structure of Figure 3;

[0028] Figure 7 is perspective view of the material of Figure 1 configured to form a grip for a bat;

[0029] Figure 8 is perspective view of the material of Figure 1 configured to form a grip for a racquet;

[0030] Figure 9 is a cross-sectional view of a second preferred embodiment of the material of the present invention illustrating a single layer of vibration dissipating material with a support structure embedded therein; the support structure is disposed within the vibration dissipating material generally along a longitudinal axis in an at least partially non linear fashion so that a length of the support structure, as measured along a surface thereof, is greater than the length of the vibration dissipating material as measured along the longitudinal axis, of the material body;

[0031] Figure 10 is an enlarged broken away view of the area enclosed by the dashed lines labeled "Fig. 10" in Figure 9 and illustrates that the "overall support structure" can actually be formed by a plurality of individual stacked support structures (which can be the same or different from each other) or a successive plurality of stacked fibers and/or a successive plurality of stacked cloth layers;

[0032] Figure 11 is a cross-sectional view of the material of Figure 9 stretched along the longitudinal axis into a second position, in which the material body is elongated by a predetermined amount relative to the first position; the straightening of the support structure causes energy to be dissipated and preferably generally prevents further elongation of the material along the longitudinal axis past the second position;

[0033] Figure 12 is a cross-sectional view of a third preferred embodiment of the material of the present invention illustrating a more linear support structure within the material while the material is in the first position; the more linear arrangement of the support structure in the material, relative to that shown in Figure 9, reduces the

amount of elongation that is possible before the material stops stretching and effectively forms a brake on further movement;

[0034] Figure 13 is a cross-sectional view of the material of Figure 12 stretched along the longitudinal axis into the second position, in which the material is elongated along the longitudinal axis by a predetermined amount; because the support structure was more linear while the material was in the first position, relative to the material shown in Figure 11, it is preferred that the amount of elongation of the material when the material is in the second position is reduced relative to the material shown in Figures 9 and 11;

[0035] Figure 14 is a cross-sectional view of a fourth preferred embodiment of the material of the present invention illustrating the support structure with an adhesive layer generally over its major surfaces to allow the elastomer material to be secured thereto rather than molded and/or extruded thereover;

[0036] Figure 15 is a cross-sectional view of a fifth preferred embodiment of the material of the present invention illustrating the support structure, or ribbon material, positioned between two spaced elastomer layers with the support structure's peaks molded, fastened, and/or otherwise affixed to the elastomer layer at a plurality of locations; air gaps are preferably present about the support structure to facilitate longitudinal stretching of the material; alternatively, the support structure can be secured only at its lateral ends (i.e., the left and right ends of the support structure viewed in Figure 15) to the elastomer layers so that the remainder of the support

structure moves freely within an outer sheath of elastomer material and functions as a spring/elastic member to limit the elongation of the material;

[0037] Figure 16 is a sixth preferred embodiment of the vibration dissipating material of the present invention and is similar to the material shown in Figure 15, except that the support structure's peaks are secured to the elastomer layers via an adhesive layer;

[0038] Figure 17 is a seventh preferred embodiment of the vibration dissipating material of the present invention and illustrates the vibration dissipating material and any accompanying adhesive actually physically breaking when the support structure is elongated into the second position; the breaking of the vibration dissipating material results in further energy dissipation and vibration absorption in addition to that dissipated by the support structure;

[0039] Figure 18 is an eighth preferred embodiment of the vibration dissipating material of the present invention and illustrates that the support structure, or ribbon material, can be disposed in any geometry within the vibration dissipating material; additionally, individually rigid squares, buttons, or plates (not shown) can be positioned on one side of the material to further spread impact force along the surface of the material prior to the dissipation of vibration by the material in general; additionally, such buttons, plates, or other rigid surfaces can be attached directly to a mesh or other flexible layer that is disposed over the material shown in Figure 18 so that impact force on one of the rigid members causes deflection of the entire mesh or

other layer for energy absorption prior to vibration absorption by the material; the section line labeled 3-3 in this Figure signifies that it is possible that the support structure shown in Figure 18 is generally the same as that illustrated in Figure 3;

[0040] Figure 19 is a cross-sectional view of a ninth preferred embodiment of the material of the present invention and illustrates that the support structure can be positioned generally along an outer surface of the vibration dissipating material without departing from the scope of the present invention; Figure 19 also illustrates that a breakable layer (i.e., a paper layer) or a self fusing adhesive layer can be located on one surface of the material; when a self fusing layer is located on one surface of the material, the material can be wrapped so as to allow multiple adjacent wrappings of the material to fuse together to form an integral piece; if desired, the integral piece may be waterproof for use with swimming or the like;

[0041] Figure 20 is a cross-sectional view of a tenth preferred embodiment of the vibration dissipating material with a shrinkable layer of material disposed on a major surface thereof; the shrinkable material can be a heat shrinkable material or any other type of shrinking material suitable for use with the present invention; once the material is properly positioned, the shrinkable layer can be used to fix the material in position and, preferably, can also be used as a separate breakable layer to further dissipate vibration in a fashion similar to the breakable layer described in connection with Figure 17;

[0042] Figure 21 is an eleventh preferred embodiment of the vibration dissipating material of the present invention and illustrates the shrinkable layer disposed within the vibration dissipating material; the shrinkable layer can be a solid layer, a perforated layer, a mesh or netting, or shrinkable fibers;

[0043] Figure 22 is a twelfth preferred embodiment of the vibration absorbing material of the present invention and illustrates the shrinkable layer being disposed over peaks of the support structure with an optional vibration absorbing layer thereover;

[0044] Figure 23 is a cross-sectional view of the material of Figure 22 when the shrinkable layer has been shrunk down over the support structure after the material is placed in a desired configuration; although the optional additional vibration absorbing material is not shown in Figure 23, it can be left in position above the shrinkable layer to form a protective sheath or also pulled down into the gaps between the peaks of the support structure;

[0045] Figure 24 illustrates the material of the present invention configured as athletic tape with an optional adhesive layer;

[0046] Figure 25 illustrates the material of the present invention as a roll of material/padding/wide wrap material or the like with an optional adhesive layer thereon;

[0047] Figure 26 illustrates the material of the present invention configured as a knee bandage;

[0048] Figure 27 illustrates the material of the present invention with an optional adhesive layer configured as a finger and/or joint bandage; while various bandages, wraps, padding, materials, tapes, or the like are shown, the material of the present invention can be used for any purpose or application without departing from the scope of the present invention;

[0049] Figure 28 illustrates the material of the present invention used to form a foot brace;

[0050] Figure 29 illustrates the material of the present invention wrapped to form a knee supporting brace;

[0051] Figure 30 illustrates additional layers of material used to brace the ligaments in a person's leg;

[0052] Figure 31 illustrates the material of the present invention used to form a hip support;

[0053] Figure 32 illustrates the material of the present invention used to form a shoulder brace; and

[0054] Figure 33 illustrates the material of the present invention wrapped to form a hand and wrist brace; while the material of the present invention has been shown in conjunction with various portions of the person's body, those of ordinary skill in the art will appreciate from this disclosure that the material of the present invention can be used as an athletic brace, a medical support, or a padding for any portion of a person's body without the departing from the scope of the present invention.

[0055] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0056] Certain terminology is used in the following description for convenience only and is not limiting. The words "right," "left," "top," and "bottom" designate directions in the drawings to which reference is made. The words "inwardly" and "outwardly" refer to directions toward and away from, respectively, the geometric center of the material and designated parts thereof. The term "implement," as used in the specification and in the claims, means "any one of a baseball bat, racquet, hockey stick, softball bat, sporting equipment, firearm, or the like." The term "particles," as used in the claims and in the corresponding portions of the specification, means "small bits or pieces of mass each defining a volume but generally being of insufficient, length to interweave together." Additionally, the words "a" and "one" are defined as including one or more of the referenced item unless specifically stated otherwise. The above terminology includes the words above specifically mentioned, derivatives thereof, and words of similar import.

[0057] Referring to Figures 1-33, wherein like numerals indicate like elements throughout, there are shown preferred embodiments of a material, generally designated 10, that is adapted to regulate vibration. Briefly stated, the material 10 preferably includes a vibration dissipating material 12 (preferably an elastomer layer). One embodiment of the vibration dissipating material 12 penetrates a support structure 17 to embed the support structure 17 thereon (as shown in Figure 2A) and/or therein (as

shown in Figure 2B). The support structure 17 is preferably semi-rigid (but can be rigid without departing from the scope of the present invention) and supports the vibration dissipating material 12. The support structure can be formed by a second elastomer layer of same or differing rigidity.

[0058] The material 10 of the present invention was the result of extensive research and was thoroughly tested by Villanova University's Department of Mechanical Engineering by a professor having a Ph.D. in vibratory physics. Testing of the material 10 determined that the material 10 can reduce the magnitude of sensible vibration by eighty (80%) percent. The material 10 has verified, superior vibration dissipation properties due to the embedded support structure 17 that is located on and/or in the elastomer 12. In addition to evenly distributing vibration, the support structure 17 contributes to the absorption of vibration and supports the vibration dissipating material 12 to prevent the layer of vibration dissipating material 12 from twisting or otherwise becoming unsuitable for use as a grip or padding.

[0059] While it is preferred that the vibration dissipating material layer 12 be formed by elastomer, those of ordinary skill in the art will appreciate from this disclosure that the vibration dissipating material 12 can be formed by any suitable polymer without departing from the scope of the present invention. For clarity only, the vibration dissipating material 12 will be often described herein as being an elastomer without any mention of the material possibly being a polymer. However, it should

understood that even when the layer 12 is only described as being an elastomer, that the present invention also includes the material 12 being a any suitable polymer.

[0060] The material 10 of the present invention can be incorporated into athletic gear, grips for sports equipment, grips for tools, and protective athletic gear. More specifically, the material 10 can be used: to form grips for a tennis racquet, hockey sticks, golf clubs, baseball bats or the like; to form protective athletic gear for mitts, headbands, mouth guards, face protection devices, helmets, gloves, to form athletic tape, to form braces, to form molded wraps for a portion of a person's body, to form pads, exercise pads, elevator pads, padding that is stood on, padding that is wrapped around objects to protect people from injury when colliding with such objects, padding that is worn for fashion, padding that is worn to ameliorate tennis elbow, padding that is used to support gun butts, padding that is used to support bullet proof vests, hip pads, shoulder pads, chest protectors, or the like; to form seats or handle bar covers for bicycles, motorcycles, or the like; to form boots for skiing, roller blading or the like; to form footwear, such as shoe soles and inserts; to form grips for firearms, hand guns, rifles, shotguns, or the like; and to form grips for tools such as hammers, drills, circular saws, chisels or the like.

[0061] The elastomer layer 12 acts as a shock absorber by converting mechanical vibrational energy into heat energy. The embedded support structure 17 redirects vibrational energy and provides increased stiffness to the material 10 to facilitate a user's ability to control an implement 20 encased, or partially encased, by the material

10. The elastomer layer 12, 12A, or 12B may include a plurality of fibers 14 (further described below) or a plurality of particles 15 (further described below). The incorporation of the support structure 17 on and/or within the material 10 allows the material 10 to be formed by a single elastomer layer without the material 10 being unsuitable for at least some of the above-mentioned uses. The support structure 17 may also include a plurality of fibers 14 or a plurality of particles 15. However, those of ordinary skill in the art will appreciate from this disclosure that additional layers of material can be added to any of the embodiments of the present invention disclosed below without departing from the scope of the invention.

[0062] In the situation where the support structure 17 is formed by a second elastomer layer, the two elastomer layers can be secured together via an adhesive layer, discreet adhesive locations, or using any other suitable method to secure the layers together. Regardless of the material used to form the support structure 17, the support structure is preferably located and configured to support the first elastomer layer (see Figures 1-2B).

[0063] It is preferred that the material 10 have a single contiguous elastomer body 12. Referring to Figure1, the support structure has first and second major surfaces 23, 25. In one embodiment, the elastomer 12 extends through the support structure 17 so that the portion of the elastomer 12A contacting the first major support structure surface 23 (i.e., the top of the support structure 17) and the portion of the elastomer 12B contacting the second major support structure surface 25 (i.e., the

bottom of the support structure) form the single contiguous elastomer body 12. Elastomer material provides vibration damping by dissipating vibrational energy. Suitable elastomer materials include, but are not limited, urethane rubbers, silicone rubbers, nitrile rubbers, butyl rubbers, acrylic rubbers, natural rubbers, styrene-butadiene rubbers, and the like. In general, any suitable elastomer or polymer material can be used to form the vibration dissipating layer 12.

[0064] The softness of elastomer materials can be quantified using Shore A durometer ratings. Generally speaking, the lower the durometer rating, the softer the material and the more effective a material layer is at absorbing and dissipating vibration because less force is channeled through the material. When a soft material is squeezed, an individual's fingers are embedded in the material which increases the surface area of contact between the user's hand and creates irregularities in the outer material surface to allow a user to firmly grasp any implement 20 covered, or partially covered, by the material. However, the softer the material, the less control a user has when manipulating an implement 20 covered by the material. If the elastomer layer is too soft (i.e., if the elastomer layer has too low of a Shore A Durometer rating), then the implement 20 may rotate unintentionally relative to a user's hand or foot. The material 10 of the present invention is preferably designed a Shore A durometer rating that provides an optimum balance between allowing a user to precisely manipulate and control the implement 20 and effectively damping vibration during use of the implement 20 depending on the activity engaged in.

[0065] It is preferable, but not necessary, that the elastomer used with the material 10 have a Shore A durometer of between approximately ten (10) and approximately eighty (80). It is more preferred that the elastomer 12 have a Shore A durometer of between approximately fifteen (15) and approximately forty-five (45).

[0066] The elastomer 12 is preferably used to absorb vibrational energy and to convert vibrational energy into heat energy. The elastomer 12 also provides a compliant and comfortable grip for a user to grasp (or provides a surface for a portion of a user's body, such as the under sole of a user's foot when the material 10 is formed as a shoe insert).

[0067] In one embodiment, the material 10 preferably has a Shore A durometer of approximately fifteen (15). In another embodiment, the material 10 preferably has a Shore A Shore Durometer of approximately forty two (42). In yet another embodiment, the material 10 preferably has a Shore A Durometer of approximately thirty-two (32). Of course, those of ordinary skill in the art will appreciate that the Shore A Durometer of the material 10 can varied without departing from the scope of the present invention.

[0068] Referring to Figures 3-5, the support structure 17 can include any one (or combination of) of a polymer, an elastomer, particles, a plurality of fibers, a plurality of woven fibers, a cloth, and a plurality of cloth layers. If the support structure 17 and the layer 12 are both polymers or both elastomers, then they can be the same or different from each other without departing from the scope of the present invention. If

vibration dissipating material 12 is formed of the same material as the support structure 17, then the support structure 17 can be made more rigid than the main layer 12 by embedding fibers 14 therein. It is preferable that the support structure 17 is generally more rigid than the vibration dissipating material 12.

[0069] Referring specifically to Figure 3, the support structure 17 may be formed of an elastomer that may but does not necessarily, also have fibers 14 embedded therein (examplary woven fibers are shown throughout portions of Figure 3). Referring to Figure 4, the support structure 17 may be formed by a plurality of woven fibers 18. Referring to Figure 5, the support structure 17 may be formed by a plurality of fibers 14. Regardless of the material forming the support structure 17, it is preferable that passageways 19 extend into the support structure 17 to allow the elastomer 12 to penetrate and embed the support structure 17. The term "embed," as used in the claim and in the corresponding portions of the specification, means "contact sufficiently to secure thereon and/or therein." Accordingly, the support structure 17 shown in Figure 2 A is embedded by the elastomer 12 even though the elastomer 12 does not fully enclose the support structure 17. Additionally, as shown in Figure 2 B, the support structure 17 can be located at any level or height within the elastomer 12 without departing from the scope of the present invention. While the passageways 19 are shown as extending completely through the support structure 17, the invention includes passageways 19 that extend partially through the support structure 17.

[0070] Referring again to Figure 2A, in one embodiment, it is preferred that the support structure 17 be embedded on the elastomer 12, with the elastomer penetrating the support structure 17. The support structure 17 being generally along a major material surface 38 (i.e., the support structure 17 is generally along the top of the material).

[0071] The fibers 14 are preferably, but not necessarily, formed of high tensile fibrous material (one example of which are aramid fibers). However, the fibers can be formed from any one or combination of the following: bamboo, glass, metal, elastomer, polymer, ceramics, corn husks, and/or any other renewable resource. By using fibers from renewable resources, production costs can be reduced and the environmental friendliness of the present invention can be increased. Referring to Figure 4, the fibers 14 can be woven to form a cloth 16 that is disposed on and/or within the elastomer 12. Multiple cloth layers 16 can be epoxied or otherwise secured together and incorporated into the support structure 17. The cloth layer 16 can be formed of woven aramid fibers or other types of fiber. The aramid fibers 14 block and redirect vibrational energy that passes through the elastomer 12 to facilitate the dissipation of vibrations. The aramid fibers 18 redirect vibrational energy along the length of the fibers 18. Thus, when the plurality of aramid fibers 18 are woven to form the cloth 16, vibrational energy emanating from the implement 20 that is not absorbed or dissipated by the elastomer layer 12 is redistributed evenly along the material 10 by the cloth 16 and preferably also further dissipated by the cloth 16.

[0072] It is preferable that the aramid fibers 18 are formed of a suitable polyamide fiber of high tensile strength with a high resistance to elongation. However, those of ordinary skill in the art will appreciate from this disclosure that any aramid fiber suitable to channel vibration can be used to form the support structure 17 without departing from scope of the present invention. Additionally, those of ordinary skill in the art will appreciate from this disclosure that loose aramid fibers or chopped aramid fibers can be used to form the support structure 17 without departing from the scope of the present invention. The fibers may also be formed of fiberglass or the like.

[0073] When the aramid fibers, or any high tensile fibrous material, 18 are woven to form the cloth 16, it is preferable that the cloth 16 include at least some floating aramid fibers 18. That is, it is preferable that at least some of the plurality of aramid fibers 18 are able to move relative to the remaining aramid fibers 18 of the cloth 16. This movement of some of the aramid fibers 18 relative to the remaining fibers of the cloth converts vibrational energy to heat energy.

[0074] Particles 15 can be located in either an elastomer layer 12, 12A, and/or 12B and/or in the support structure 15. The particles 15 increase the vibration absorption of the material of the present invention. The particles 15 can be formed of pieces of glass, polymer, elastomer, chopped aramid, ceramic, chopped fibers, sand, gel, foam, metal, mineral, glass beads, or the like. Gel particles 15 provide excellent vibration dampening due their low durometer rating. One exemplary gel that is

suitable for use the present invention is silicone gel. However, any suitable gel can be used without departing from the present invention.

[0075] The material 10 may be configured and adapted to form an insert for shoe. When the material 10 is configured to form a shoe insert, the material 10 is preferably adapted to extend along an inner surface of the shoe from a location proximate to a heel of the shoe to the toe of the shoe. In addition to forming a shoe insert, the material 10 can be located along the sides and top of the shoe to protect the wearer's foot from lateral and vertical impacts.

[0076] The material 10 may be configured and adapted to form a grip 22 for an implement such as a bat, having a handle 24 and a proximal end 26 (i.e., the end near to where the bat is normally gripped). The material 10 is preferably adapted to enclose a portion of the handle 24 and to enclose the proximal end 26 of the bat or implement 20. As best shown in Figures 7 and 8, it is preferable that the grip 22 be formed as a single body that completely encloses the proximal end of the implement 20. The material 10 may be also be configured and adapted to form a grip 22 for a tennis racket or similar implement 20 having a handle 24 and a proximal end 26.

[0077] While the grip 22 will be described below in connection with a baseball or softball bat, those of ordinary skill in the art will appreciate that the grip 22 can be used with any of the equipment, tools, or devices mentioned above without departing from the scope of the present invention.

[0078] When the grip 22 is used with a baseball or softball bat, the grip 22 preferably covers approximately seventeen (17) inches of the handle of the bat as well as covers the knob (i.e., the proximal end 26 of the implement 20) of the bat. The configuration of the grip 22 to extend over a significant portion of the bat length contributes to increased vibrational damping. It is preferred, but not necessary, that the grip 22 be formed as a single, contiguous, one-piece member.

[0079] Referring to Figure 1, the baseball bat (or implement 20) has a handle 24 including a handle body 28 having a longitudinal portion 30 and a proximal end 26. The material 10 preferably encases at least some of the longitudinal portion 30 and the proximal end 26 of the handle 24. The grip material 10 can incorporate any of the above-described support structures 17. The aramid fiber layer 14 is preferably formed of woven aramid fibers 18.

[0080] As best shown in Figures 7 and 8, the preferred grip 22 is adapted for use with an implement 20 having a handle and a proximal handle end. The grip 22 includes a tubular shell 32 having a distal open end 34 adapted to surround a portion of the handle and a closed proximal end 36 adapted to enclose the proximal end of the handle. It is preferable not necessary, that the material completely enclose the proximal end 26 of the handle. The tubular shell 32 is preferably formed of the material 10 which dissipates vibration.

[0081] Multiple methods can be used to produce the composite or multi-layer material 10 of the present invention. Briefly speaking, one method is to extrude the

material 10 by pulling a support structure 17 from a supply roll while placing the elastomer layer on both sides of the support structure 17. It is preferred, but not necessary, that the particles 15 in either of the support structure 17 or the elastomer layer are already located in their respective material on the appropriate supply roll. A second method of producing the material 10 of the present invention is to weave a fiber onto the implement 20 and then to mold the elastomer 12 thereover. Alternatively, a support structure can be pressure fit to an elastomer to form the material 10. Those of ordinary skill in the art will appreciate from this disclosure that any other known manufacturing methods can be used to form the material 10 without departing from the scope of the present invention. Any of the below described methods can be used to form a material 10 or grip 22 having any of the above specified Shore A Durometers and incorporating any of the above-described support structures 17.

[0082] More specifically, one preferred method of making the material 10 includes:

[0083] providing an uncured elastomer 12. A cloth layer is positioned on and/or within the uncured elastomer 12. The cloth layer is formed by a plurality of woven aramid fibers 14. The uncured elastomer 12 penetrates the cloth layer 16 to embed to the cloth 16. The uncured elastomer 12 is at least partially cured to form the material 10. The cloth layer 16 supports the cured elastomer 12 and facilitates the distribution and dissipation of vibration by the material 10.

[0084] It is preferable that the elastomer 12 is cured so that some of the plurality of aramid fibers in the cloth layer 16 are able to move relative to the remaining plurality of aramid fibers 18. It is also preferable that the material 10 be configured to form a grip for a bat and/or racquet having a handle 24 and the proximal end 26. The grip 22 preferably encloses at least a portion of the handle 24 and the proximal end 26.

[0085] Another aspect of the present invention is directed to a method of making a grip 22 for an implement 20 having a handle 24 and a proximal end 26. The grip 22 is formed by a single layer material 10 adapted to regulate vibration. The method includes providing an uncured elastomer. A plurality of fibers 14 are positioned on and/or within the uncured elastomer 12. The uncured elastomer 12 is at least partially cured to form the single layer material embedding the plurality of fibers. The single layer material 10 has first and second major material surfaces. The single layer material 10 is positioned over at least a portion of the handle 24 and over the proximal end 26 of the handle 24. The first major material surface contacts the implement 20 and second major material surface of the single layer material 10 forms a surface for a user to grasp. This method can be used to form a grip 22 having any of the Shore A Durometers described above and can use any of the support structure 17 also described above.

[0086] In another aspect, the present invention is directed to a method of making a material 10 adapted to regulate vibration. The method includes providing a cloth 16 formed by a plurality of woven aramid fibers 14. The cloth has first and second major

surfaces. A first elastomer layer 12A is placed on the first major surface of the cloth. A second elastomer layer 12B is placed on the second major surface 25 of the cloth 16. The first and second elastomer layers 12A, 12B penetrate the cloth 16 to form a single layer elastomer 12 having an embedded cloth 16 for support thereof.

[0087] In another aspect, the present invention is directed to a method of forming a material 10 including providing a cloth layer 16. Positioning an elastomer 12 substantially over the cloth layer 16. Applying pressure to the cloth layer 16 and the elastomer 12 to embed the cloth layer 16 on and/or in the elastomer 12 to form the material 10. When using this sort of pressure fit technique, those ordinary skill in the art will appreciate from this disclosure that the cloth layer 16 and the elastomer 12 can be placed in a mold prior to applying pressure without departing from the scope of the present invention.

[0088] The covering of the proximal end of an implement 20 by the grip 22 results

[0089] in reduced vibration transmission and in improved counter balancing of the distal end of the implement 20 by moving the center of mass of the implement 20 closer to the hand of a user (i.e., closer to the proximal end 26). This facilitates the swinging of the implement 20 and can improve sports performance while reducing the fatigue associated with repetitive motion.

[0090] In addition to use with implements or as covers, the material shown in Figures 1-6 can be used as: an athletic tape, padding, bracing material, or the like (as shown in Figures 24-33) without departing from the scope of the present invention.

Referring to Figures 2-9, and 12; an athletic tape for wrapping a portion of a person's body; a material having a stretch axis and being adapted to regulate energy by disputing and partially dissipating energy exerted thereon; a padding for covering a portion of a person's body or an object; and/or a brace for wrapping a portion of a person's body is shown. For simplicity, the material 10 will be initially described in connection with athletic tape, but those of ordinary skill in the art will appreciate from this disclosure that the material 10 can be used in any of the above described applications or in any other application where vibration absorption or having a controlled material stretch is desired.

[0091] When the material of the present invention is used to form athletic tape, that athletic tape provides a controlled support for a portion of the person's body. The athletic tape includes a tape body 64 that is preferably stretchable along a longitudinal axis 48 (or stretch axis 50) from a first position to a second position, in which the tape body 64 is elongated by a predetermined amount relative to the first position.

[0092] Figures 9 and 11 illustrate a second preferred embodiment of the material of the present invention in the first and second positions, respectively. Figures 12 and 13 illustrate a third preferred embodiment of the material of the present invention in the first and second positions, respectively.

[0093] As described below, the configuration of the support structure 17 within the vibration absorbing layer 12 allows the predetermined amount of elongation to be generally fixed so that the athletic tape provides a controlled support that allows

limited movement before applying a brake on further movement of the wrapped portion of a person's body. This facilitates movement of a wrapped joint while simultaneously dissipating and absorbing vibration to allow superior comfort and performance as compared to that experienced with conventional athletic tape. While the predetermined amount of elongation can be set to any value, it is preferably less than twenty (20%) percent. The predetermined amount of elongation is more preferably less than two (2%) percent. However, depending on the application any amount of elongation can be used with the material 10 of the present invention.

[0094] The tape body 64 preferably includes a first elastomer layer 12 that defines a tape length 66, as measured along the longitudinal axis 48, of the tape body 64. The support structure 17 is preferably disposed within the elastomer layer 12 generally along the longitudinal axis 48 in an at least partially non linear fashion while the tape body is in the first position so that a length of the support structure 17, as measured along a surface thereof, is greater than the tape length 66 of the first elastomer layer 12. It is preferred, by not necessary, that the support structure 17 (or ribbon material) is positioned in a generally sinusoidal fashion within the elastomer layer 12 while the tape body 64 is in the first position. However, the support structure 17 can be positioned in an irregular fashion without departing from the scope of the present invention. As described above, the support structure 17 and/or the elastomer layer 12 can include particles, fibers, or the like (as shown in Figures 12 and 13).

[0095] Referring to Figures 11 and 13, when the tape body 64 is stretched into the second position, the support structure 17 is preferably at least partially straightened so that the support structure 17 is more linear (or in case of the material shown in Figure 2, the support structure 17 would likely be thinner), relative to when the tape body 64 is in the first position (as shown in Figures 2, 9, and 12). The straightening of the support structure causes energy to be dissipated and preferably generally prevents further elongation of the elastomer layer 12 along the longitudinal axis 48 past the second position. Energy dissipation occurs due to the stretching of the material of the support structure 17 and can occur due to the separation or partial pulling away of the support structure 17 from the attached elastomer layer 12.

[0096] Referring to Figure 10, the "overall support structure" 17 may comprise a plurality of stacked support structures, fibers 18, and/or cloth layers 16. It is preferred that the plurality of fibers include aramid fibers or other high tensile strength fibrous material. Alternatively, the plurality of fibers may be formed of fiberglass material or be woven into a ribbon or cloth. Additionally, as described above in connection with Figures 2-6, the support structure can include any one (or combination) of a polymer, an elastomer, particles; fibers; woven fibers; a cloth; a plurality of cloth layers; loose fibers, chopped fibers, gel particles, particles, sand, or the like without departing from the scope of the present invention.

[0097] As detailed above, the support structure 17 and/or the elastomer layer 12 may include a plurality of particles therein. Such particles may include any one or

combination of gel particles, sand particles, glass beads, chopped fibers, metal particles, foam particles, sand, or any other particle in parting desirable vibration dissipation characteristics to the material 10.

[0098] Referring to Figures 9 and 10, it is preferred that the tape body 64 have top and bottom surfaces 68A, 68B, respectively. The bottom surface 68B faces the portion of the person's body when the athletic tape 10 is wrapped thereover. When the support structure 17 is formed by a plurality of fibers 18, it is preferable that the plurality of fibers 18 define multiple stacked fiber layers between the top and bottom surfaces 68A, 68B. It is preferable that the plurality of fibers 18 are stacked between four (4) and sixteen (16) times between the top and bottom surfaces 68A, 68B. It is more preferable still that the plurality of fibers are stacked ten (10) times. As described above, the plurality of fibers 18 may include metal fibers, high tensile strength fibrous material, ceramic fibers, polymer fibers, elastomer fibers, or the like without departing from the scope of the present invention. As shown in Figure 19, the support structure 17 may be disposed only partially within or on the elastomer layer generally along the longitudinal axis without departing from the scope of the present invention.

[0099] Referring again to Figures 9-13, the material of the present invention can be an all purpose material for use as desired by a person to regulate energy by distributing and partially dissipating energy exerted thereon. When the material 10 of the present is used as an all purpose material, the all purpose material 10 includes a material body 70 that is elongateable along the stretch axis 50 from a first position

(shown in Figures 2, 9, and 12) to a second position (shown in Figures 11 and 13), in which the material body 70 is elongated by a predetermined amount relative to the first position. The stretch axis 50 is preferably determined during manufacturing by the orientation and geometry of the support structure 17 which preferably limits the directions in which the material body 70 can elongate. If multiple separate material bodies 70 are stacked together, it may be desirable to have the stretch axis 50 of the individual material bodies 70 oriented askew from each other.

[00100] The first elastomer layer 12 defines a material length 72, as measured along the stretch axis 50 of the material body 70. The support structure 17 is preferably disposed within the elastomer layer 12 generally along the stretch axis 50 in an at least partially non linear fashion while the material body 70 is in the first position so that a length of the support structure, as measured along the surface thereof, is greater than the material length 72 of the first elastomer layer. When the material body 70 is elongated into the second position, the support structure 17 is at least partially straightened so that the support structure is more linear, relative to when the material body 70 is in the first position.

[00101] The support structure 17 is preferably positioned in a sinusoidal fashion within any of the materials 10 of the present invention. The support structure 17 or ribbon may also be positioned in the form of a triangular wave, square wave, or an irregular fashion without departing from the scope of the present invention.

[00102] Any of the materials of the present invention may be formed with an elastomer layer 12 formed by silicone or any other suitable material. Depending upon the application, the vibration absorbing material 12 may be a thermoset and/or may be free of voids therein.

[00103] Any of the embodiments of the material 10 of Figures 1-33 can be used as an implement cover, grip, athletic tape, an all purpose material, a brace, and/or padding. When the material 10 of the present invention is used as part of a padding, the padding includes a padding body 74 that is elongateable along the stretch axis from a first position (shown in Figures 2, 9, and 12) to a second position (shown in Figures 11 and 13), in which the padding body 74 is elongated by a predetermined amount relative to the first position. The padding includes a first elastomer layer 12 which defines a padding length 76,as measured along the stretch axis 50 of the padding body 74.

[00104] The support structure 17 is disposed within the elastomer layer 12 generally along the stretch axis 50 in an at least partially non linear fashion while the padding body 74 is in the first position so that a length of the support structure 17, is measured along a surface thereof, is greater than the padding length 76 of the first elastomer layer 12. When the padding body 74 is elongated into the second position, the support structure 17 is at least partially straightened so that the support structure is more linear, relative to when the padding body 74 is in the first position. The straightening of the support structure 17 causes energy to be dissipated and generally

prevents further elongation of the elastomer layer along the stretch axis 50 past the second position.

[00105] When the materials 10 of the present invention are incorporated as part of a brace, the brace provides a controlled support for a wrapped portion of a person's body. The brace includes a brace body 78 that is elongateable along the stretch axis 50 from a first position (shown in Figures 2, 9, and 12) to a second position (shown in Figures 11 and 13), in which the brace body 78 is elongated by a predetermined amount relative to the first position. The brace body includes a first elastomer layer 12 that defines a brace length 80, as measured along the stretch axis 50, of the brace body 78.

[00106] The support structure 17 is preferably disposed within the elastomer layer generally along the stretch axis 50 in an at least partially non linear fashion while the brace body 78 is in the first position so that a length of the support structure 17, as measured along a surface thereof, is greater than the brace length 80 of the first elastomer layer 12. When the brace body 78 is stretched into the second position, the support structure 17 is at least partially straightened so that the support structure 17 is more linear, relative to when the brace body 78 is in the first position. The straightening of the support structure 17 causes energy to be dissipated and preferably generally prevents further elongation of the elastomer layer 12 along the stretch axis past the second position. Those ordinarily skilled in the art will appreciate that any of the materials 10 of the present invention may be formed into a one piece brace that

provides a controlled support as described above without departing from the scope of the present invention.

[00107] Referring to Figures 9 and 12, depending upon the geometry of the support structure 17 when the material 10 is in the first position, the amount of stretch of the material 10 can be selected. It is preferred that the percentage increase in the material length when the body 64, 70, 74, 78 moves from the first position to the second position is selected based on a desired range of motion. When the material 10 is configured as an athletic tape, the athletic tape may be wrapped about a portion of a person's body multiple times, if necessary, to form a brace. Alternatively, a single layer of material 10 can be wrapped on a person and secured in place using conventional athletic tape or the like. It is preferable that the successive wrappings of athletic tape are affixed to each other to form a generally one piece brace. This can be accomplished by using tape that is self fusing to allow multiple adjacent wrappings of the athletic tape to fuse together to form an integral piece. One method of fusing wrappings of the athletic tape is for the elastomer layer of each of the multiple adjacent wrappings to contact the elastomer layer of the adjacent wrappings to fuse together to form a single elastomer layer. Self fusing technology can be used with any of the materials 10 of the present invention and can be used in any of the applications for which those materials are suitable. By way of non limiting example, self fusing material 10 can be used with baseball bats, lacrosse sticks, tennis rackets, gun covers and wraps, implements, sports implements, tape, padding, braces, or the like.

[00108] Referring to Figures 14,16, and 17, adhesive 52 may be used to connect the support structure 17 to the vibration absorbing material 12. Referring to Figures 15-17, air gaps 60 can be present proximate to the support structure 17 without departing from the scope of the present invention. Referring to Figure 15, the sixth preferred embodiment of the material of the present invention can be secured at its peak 62 to the vibrating absorbing material 12 or can be secured only at its ends with the vibration absorbing material 12 forming a protective sheath for the support structure 17 which would act as an elastic member in this instance.

[00109] Figures 20-23 illustrate the material 10 of the present invention incorporating a shrink layer 58 which can be used to secure the material 10 in position. Additionally, the shrinkable layer 58 may be configured to break when a certain stress threshold is reached to provide further energy dissipation. Referring to Figure 22, a shrinkable layer 58 is in its pre-shrink configuration. Referring to Figure 23, once the shrinkable layer 58 has been activated, the shrinkable layer 58 preferably deforms about one side of the support structure 17 to hold the material 10 in position. The shrinkable layer 58 can be heat or water activated. Alternative known activation methods are also suitable for use with the present invention.

[00110] Figure 17 illustrates a seventh preferred embodiment of the present invention in which the vibration absorbing layer 12 is configured to break apart during the elongation of the support structure 17 to allow for greater energy dissipation.

[00111] Any of the materials 10 of the present invention can be used in conjunction with additional layers of rigid or flexible materials without departing from the scope of the present invention. For example, the materials 10 of the present invention may be used with a hard shell outer layer which is designed to dissipate impact energy over the entire material 10 prior to the material 10 deforming to dissipate energy. One type of rigid material that can be used in combination with the materials 10 of the present invention is molded foam. Molded foam layers preferably include multiple flex seams that allow portions of the foam layer to at least partially move relative to each other even though the overall foam layer is a single body of material. This is ideal for turning an impact force into a more general blunt force that is spread over a larger area of the material 10. Alternatively, individual foam pieces, buttons, rigid squares, or the like can be directly attached to an outer surface of any of the materials 10 of the present invention. Alternatively, such foam pieces, buttons, rigid squares, or the like can be attached to a flexible layer or fabric that will dissipate received impact energy over the length of the fabric fibers prior to the dissipation of energy by the material 10.

[00112] It is recognized by those skilled in the art, that changes may be made to the above-described embodiments of the invention without departing from the broad inventive concept thereof. For example, the material 10 may include additional layers (e.g., two or more additional layers) without departing from the scope of the present invention. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but is intended to cover all modifications which are within the

spirit and scope of the invention as defined by the appended claims and/or shown in the attached drawings.

*    *    *